Summer 1997 in Perspective
by
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This report serves two objectives: the first is to assess the severity of the summer 1997 ozone season; the intent of the assessment is to provide an historical (climatological) perspective. The second objective is to identify and document the meteorological conditions associated with high ozone events during the summer.

Historical Perspective

Since monitoring for photochemical oxidants began in earnest it has been observed that some summers are more prone than others to widespread high concentrations of ozone. Summers noted for such ozone episodes have included 1980, 1983, 1988, 1991, and 1995. Many of these same summers are also noted for excessive heat and regional drought; in particular, the summer of 1988 (an extreme season for ozone) was also an extreme summer for drought.

The correlation of high ozone with summer heat and drought is used in the following to provide perspective for the relatively short term ozone database; this is useful for assessing whether a particular ozone season could be considered normal or abnormal based on climatology. The assessment makes use of the 103-year (1895-1997) drought database maintained by the National Climatic Data Center (NCDC). The basic data consist of monthly temperature and precipitation values covering 9 climatic regions in the contiguous United States (Figure 1). Processing involved ranking the years based on summer (June - August) temperature and precipitation. An 18-year (1980-1997) subset of the rankings was then extracted for evaluation and comparison.

National Perspective

The national perspective is presented in Figures 2a (temperature) and 2b (precipitation). Abnormal summers (summers which rank within the top 20 percent for temperature and/or precipitation) are noted by including the numerical value of the rank in the graphics. For example, as seen in Figure 2a, four years (1980, 1983, 1988, and 1994) fall within the top 20 percent for temperature. The rank is interpreted such that the '9' above the vertical bar for 1980 in Figure 2a indicates that 1980 was the 9th warmest summer since 1895. A rank of 1 for temperature would indicate the warmest summer on record (103 years); similarly a rank of 1 for precipitation would indicate the driest summer on record.

Abnormally warm, dry summers (an indication of climatological drought) and, by inference, summers noted for high ozone concentrations, include: 1980 (the 9th warmest and 3rd driest), 1983 (the 21st warmest and 16th driest), and 1988 (the 3rd warmest and 6th driest). The

summer of 1997 (67th warmest and 24th driest), by comparison, was unremarkable.

Regional Perspective

Similar graphics for the six most eastern climate regions are presented in Figure 3. The summer of 1997, again, is unremarkable. By comparison the summer of 1995 stands out as an extreme in the Northeast (the 3rd warmest and 2nd driest summer in 103 years). Other extreme summers (since 1980) and the regions affected are listed in Table 1.

Table 1
Extreme* Summers since 1980 and Regions Affected

		Rank for	
Climate Region	Year	Temperature	Precipitation
National	1980	9	3
	1983	21	16
	1988	3	6
Northeast	1993	13	16
	1995	3	2
East North-Central	1988	1	8
Central	1983	12	4
	1988	15	7
Southeast	1980	15	1
	1987	10	12
	1993	2	3
West North-Central	1988	2	3
South	1980	2	3

* Ranked in the top fifth of the 103-year distribution for both temperature (1 = warmest) and precipitation (1 = driest). Based on the 103-year NCDC drought database 1895-1997.

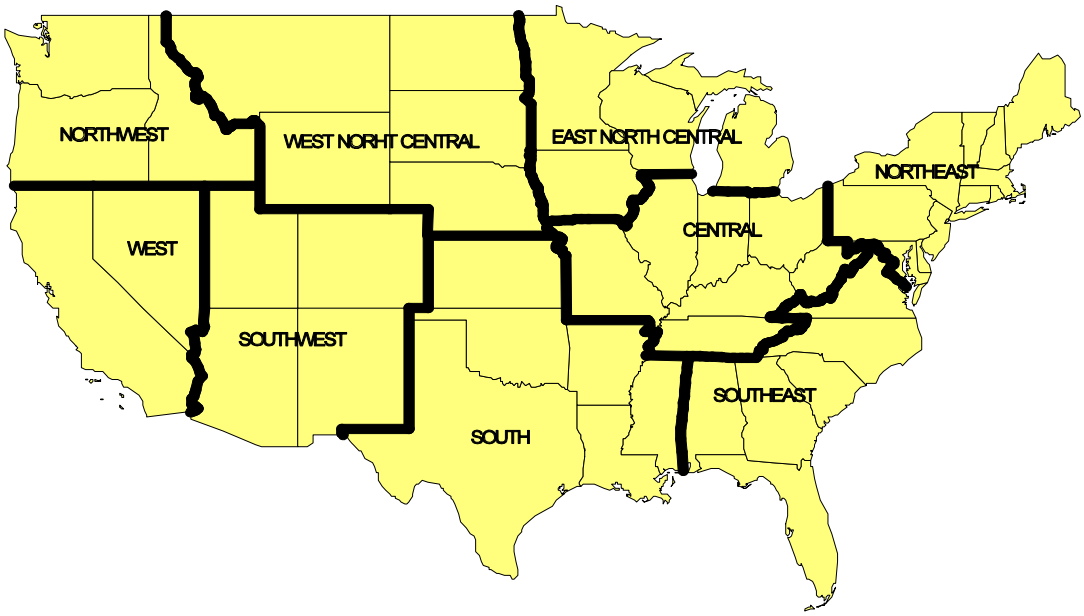

Figure 1 U.S. Climate Regions

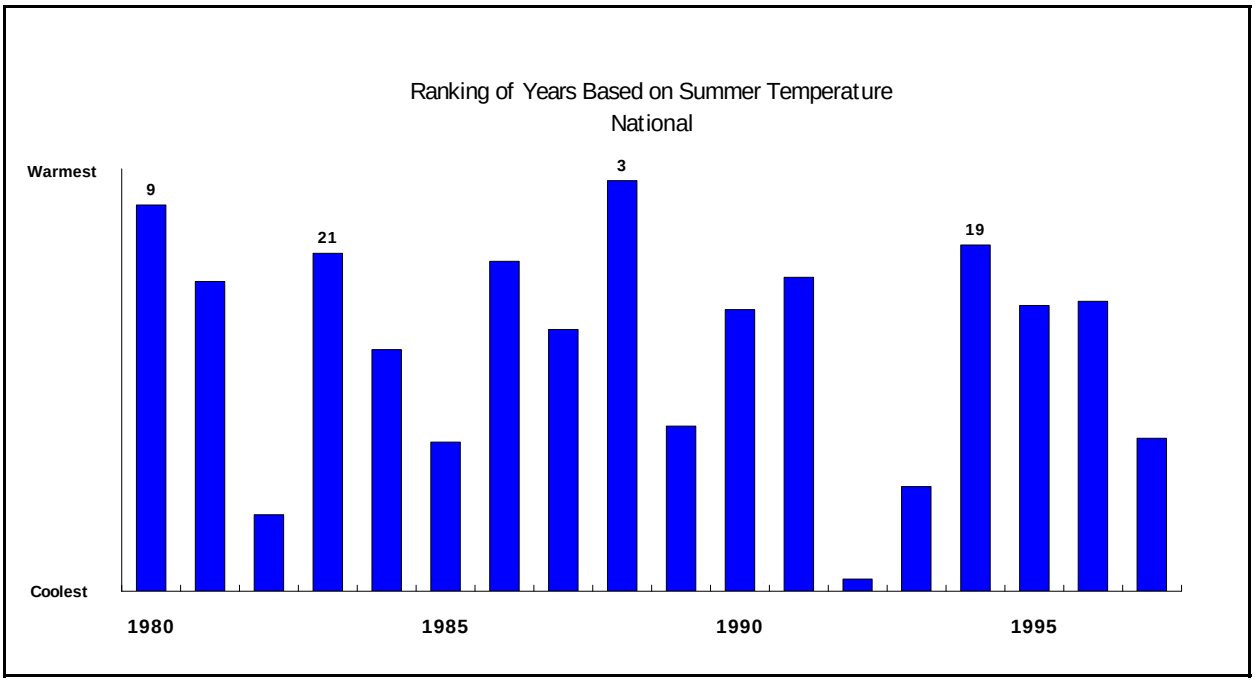

Figure 2a Ranking of years based on summer temperature

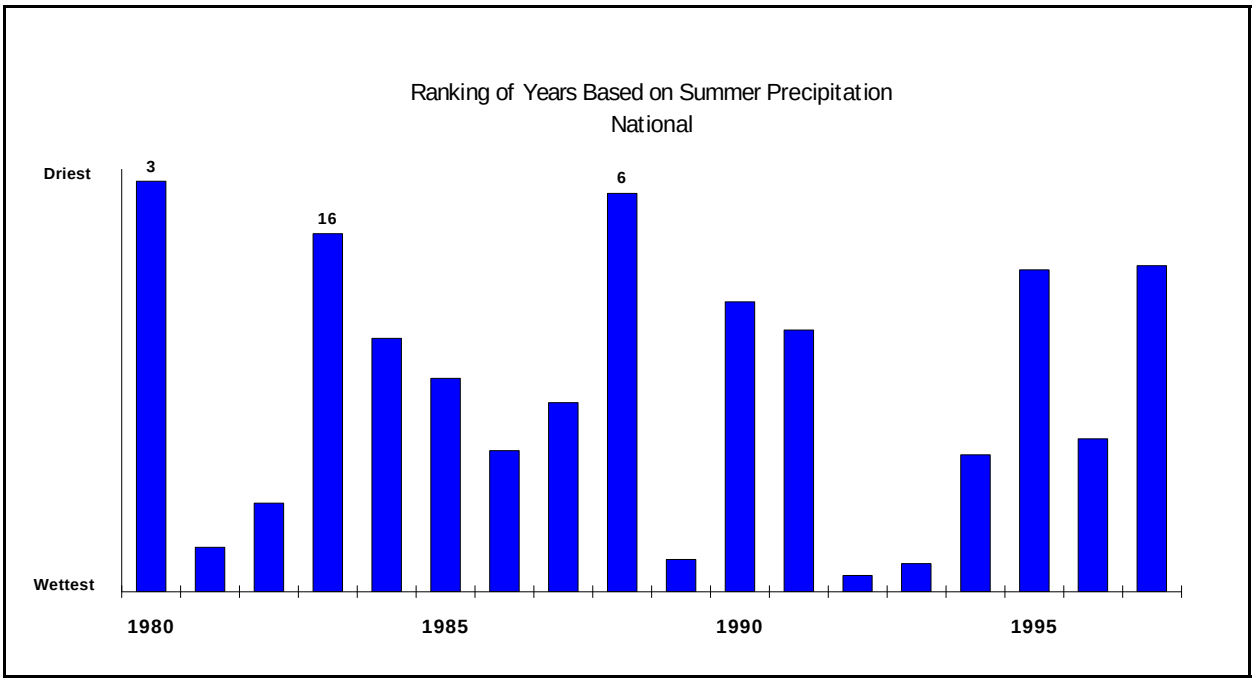

Figure 2b Ranking of years based on summer precipitation

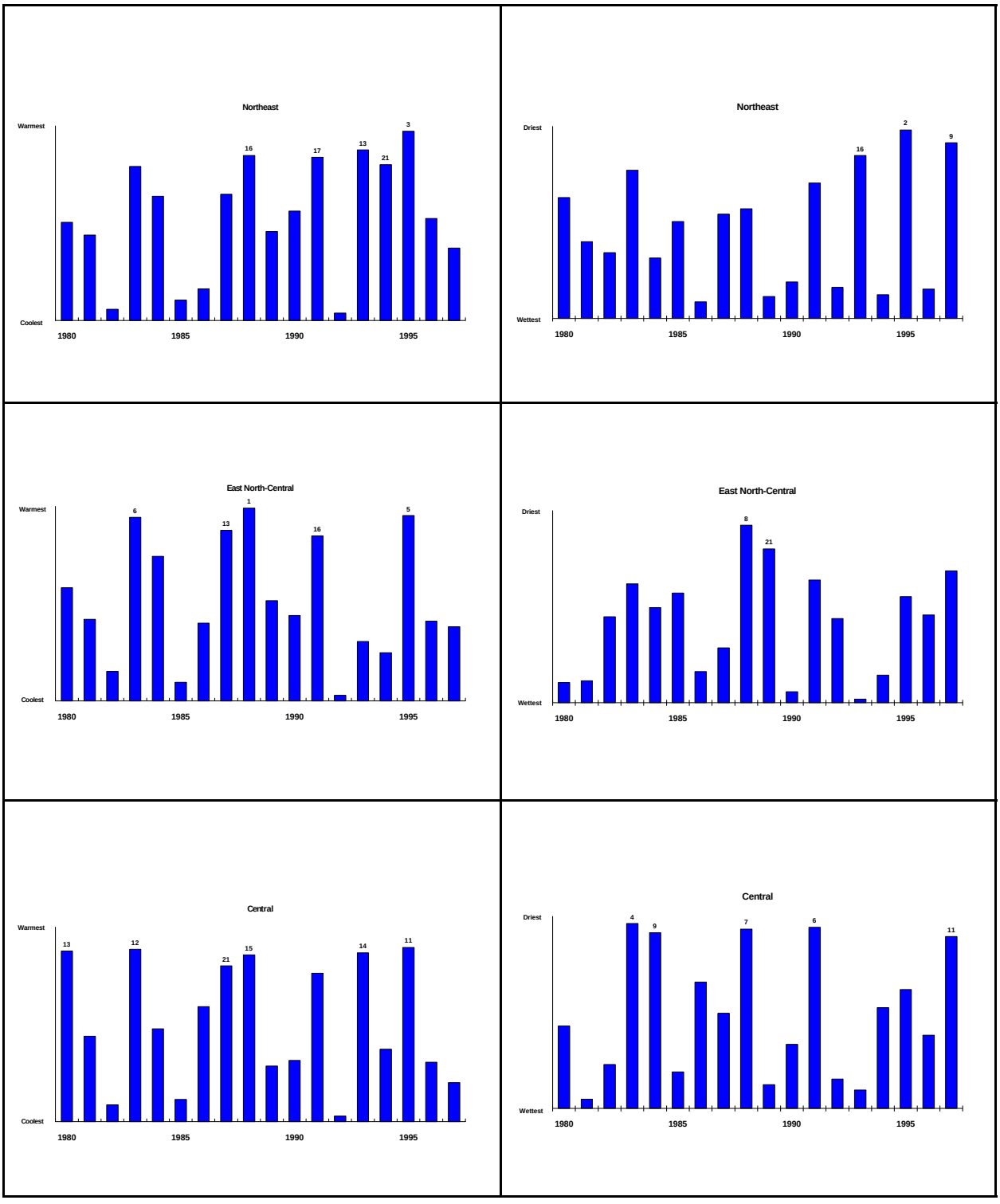

Figure 3 **Ranking of years based on summer temperature (left panel) and precipitation (right panel)**

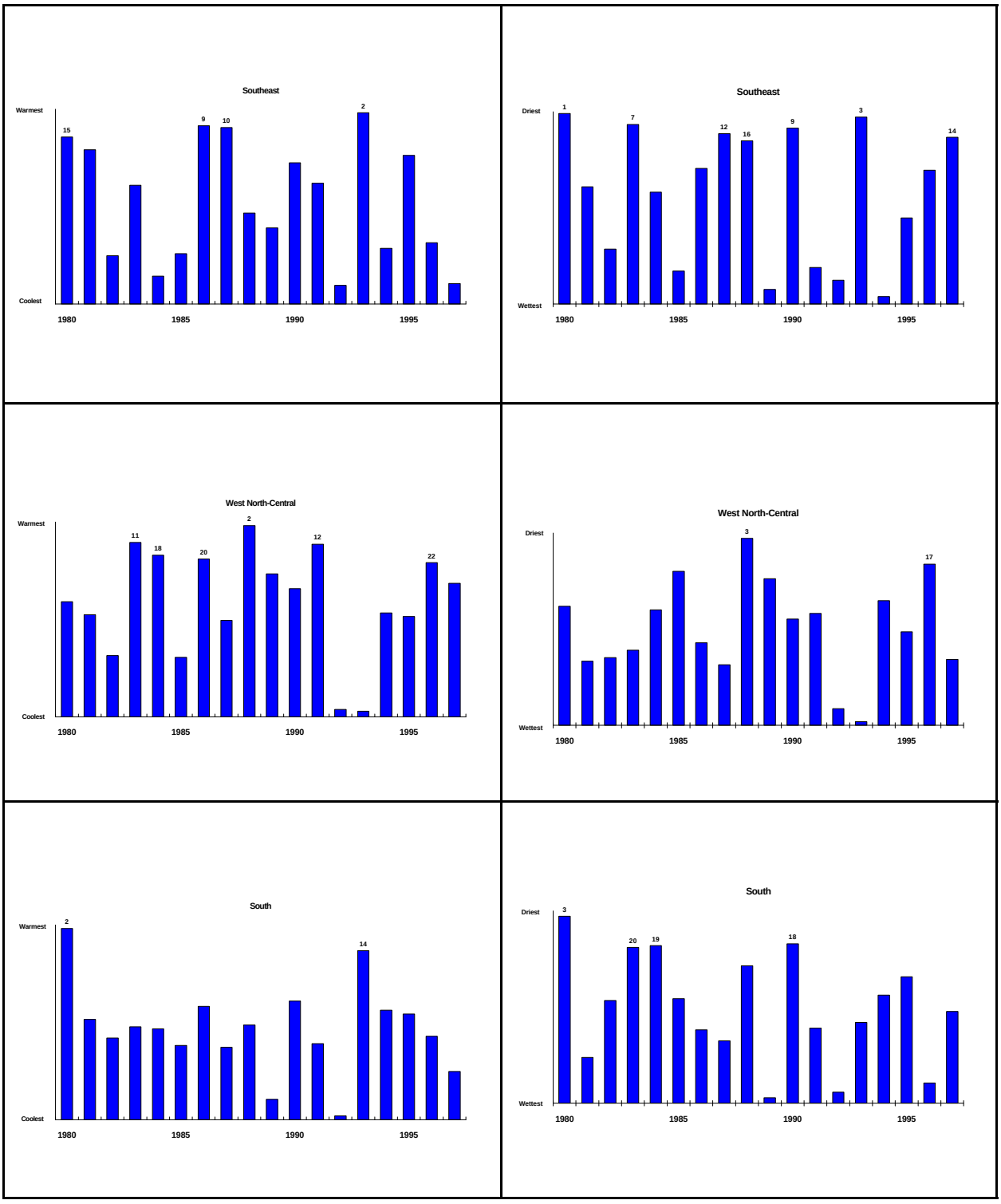

Figure 3 (continued) Ranking of years based on summer temperature (left panel) and precipitation (right panel)

1997 Ozone Events

Two databases providing information on ozone exceedances were reviewed for the purpose of identifying high ozone events during the summer of 1997. The first database was compiled by Northeast States for Coordinated Air Use Management (NESCAUM) and made available on the Northeast Airshed Regional Data Analysis Toolshed (NEARDAT) Web site. The second database, the ozone "fast track" database, was compiled by EPA. Although the information in both databases is preliminary (the raw data have not been subject to quality assurance procedures) and thus subject to change, it is not expected that this will significantly effect the identification of ozone event days.

The results of the review of these two databases are summarized in Tables 2 (June), 3 (July), and 4 (August) where each day is classified based on the number of sites exceeding the standard in each region. With the exception of Region VI, there were no exceedances prior to June 20, 1997. Regions VIII, and X are not included in the Table as there were no exceedances. Monitoring data for Region IX were not included in the analysis.

There were multiple periods during the summer which qualify as ozone events in one or more regions. One of the more significant events during the summer, an event which impacted all of the eastern regions, occurred during the period July 12 through July 17. Preliminary information for the most extreme day (July 15) include reported concentrations of 187 ppb at Stratford CT, 176 ppb at Colliers Mills NJ, 185 ppb at Ft. Meade MD, and 197 ppb in the Houston/Galveston area. The meteorological conditions associated with this event are documented in the following.

Meteorological Conditions July 12 - 17, 1997

The following discussion refers to the surface weather charts presented in Figures 4 (July 11) through 11 (July 18). Weak surface pressure gradients resulted in surface winds that were light and variable over the eastern third of the nation throughout the period; this in combination with relatively dry conditions with no significant precipitation led to a buildup of ozone precursors during the period. As seen in Figures 4-7, high pressure dominated the weather conditions in the eastern third of the nation from July 11-14. A weak trough associated with low pressure over the western Great Lakes on July 14 moved through to the eastern seaboard on July 16 (Figures 7-9). However, as evidenced by the relatively uniform surface temperatures (Figures 8 and 9), it does not appear that the trough affected any significant change in air mass. High pressure began rebuilding over the eastern third of the nation on July 17-18 (Figures 10-11).

Although not a typical stagnation episode (because of the passage of the trough) the affect on air quality was similar to what one would expect with stagnation; e.g., air quality continued to deteriorate even after passage of the trough. Local influences on air flow would have been significant because of weak synoptic pressure gradients which prevailed throughout

the period; recirculations associated with such influences probably contributed to the poor air quality encountered in many locations. Because of the weak circulation, transport does not appear to have been a major factor.

As with most ozone episodes, surface temperatures were quite high. Temperatures on Monday (July 14) were the highest since 1995 in Indianapolis, IN (95 degrees F) and St. Louis, MO (98 degrees F). Farther east, highs on Tuesday (July 15) soared to daily-record levels in locations such as Wilmington, DE and Raleigh-Durham, NC (both 99 degrees F). Wilmington's maximum was their highest since 1995. During the mid- to late-week period, highs again soared into the lower to middle 90's across the Corn Belt, and remained in the upper 90's to near 100 degrees F in the Middle Atlantic region. On Thursday (July 17), Newark, NJ notched 100 degrees F. A day later (on July 18), Harrisburg, PA recorded 101 degrees F.

Conclusions

In terms of severity, the summer of 1997 was unremarkable when compared to past summers noted for ozone episodes; e.g., 1980, 1983, 1988, and 1995. There were multiple periods during the summer which qualify as ozone events in one or more regions. One of the more significant events during the summer, an event which impacted all of the eastern regions, occurred during the period July 12 through July 17. Preliminary analysis of the meteorological conditions associated with this event indicate that stagnation was a significant contributing factor to the high ozone levels during this period.

Table 2 Classification of days in June 1997 based on exceedances of the ozone standard

	EPA Region						
Day	I	II	III	IV	V	VI	VII
1							
2							
3						*	
4						**	
5						**	
6						*	
7							
8							
9							
10						*	
11						**	
12							
13							
14							
15							
16							
17							
18						*	
19							
20		*	***				
21	***	**	**				
22	**						
23					*		
24		*	***		***	*	
25	****	**	*				
26						*	
27							
28							
29	**	**			****		
30	***						

Key:		
		no sites exceeded the standard
	*	1 site exceeded the standard
	**	2-5 sites exceeded the standard
	***	6-10 sites exceeded the standard
	****	11-20 sites exceeded the standard
	*****	more than 20 sites exceeded the standard

Table 3 Classification of days in July 1997 based on exceedances of the ozone standard

	EPA Region						
Day	I	II	III	IV	V	VI	VII
1	***					*	
2							
3			*			*	
4							
5							
6							
7							
8		**	**				
9			*				
10							
11							
12			**	*	***		
13		**	***	**			
14	**	***	*****	**		*	
15	***	****	****			*	
16		**	**			**	
17	**		***		**	**	
18				*	*	*	*
19				*			
20							**
21			*	*			
22							
23						*	
24						*	
25					*	*	
26	*		*	**	**		
27	**		**	**		*	
28			**	**			
29						**	
30							
31							

Key:		
		no sites exceeded the standard
	*	1 site exceeded the standard
	**	2-5 sites exceeded the standard
	***	6-10 sites exceeded the standard
	****	11-20 sites exceeded the standard
	*****	more than 20 sites exceeded the standard

Table 4 Classification of days in August 1997 based on exceedances of the ozone standard

	EPA Region						
Day	I	II	III	IV	V	VI	VII
1				*	**		
2				*		*	
3				*			
4						**	
5							
6						**	
7							
8							
9							
10	*						
11							
12							
13							
14							
15							
16							
17							
18							
19				*			
20							
21						*	
22							
23						*	
24							
25						**	
26				*		**	
27				**		**	
28							
29							
30						**	
31						****	

Key:		
		no sites exceeded the standard
	*	1 site exceeded the standard
	**	2-5 sites exceeded the standard
	***	6-10 sites exceeded the standard
	****	11-20 sites exceeded the standard
	*****	more than 20 sites exceeded the standard

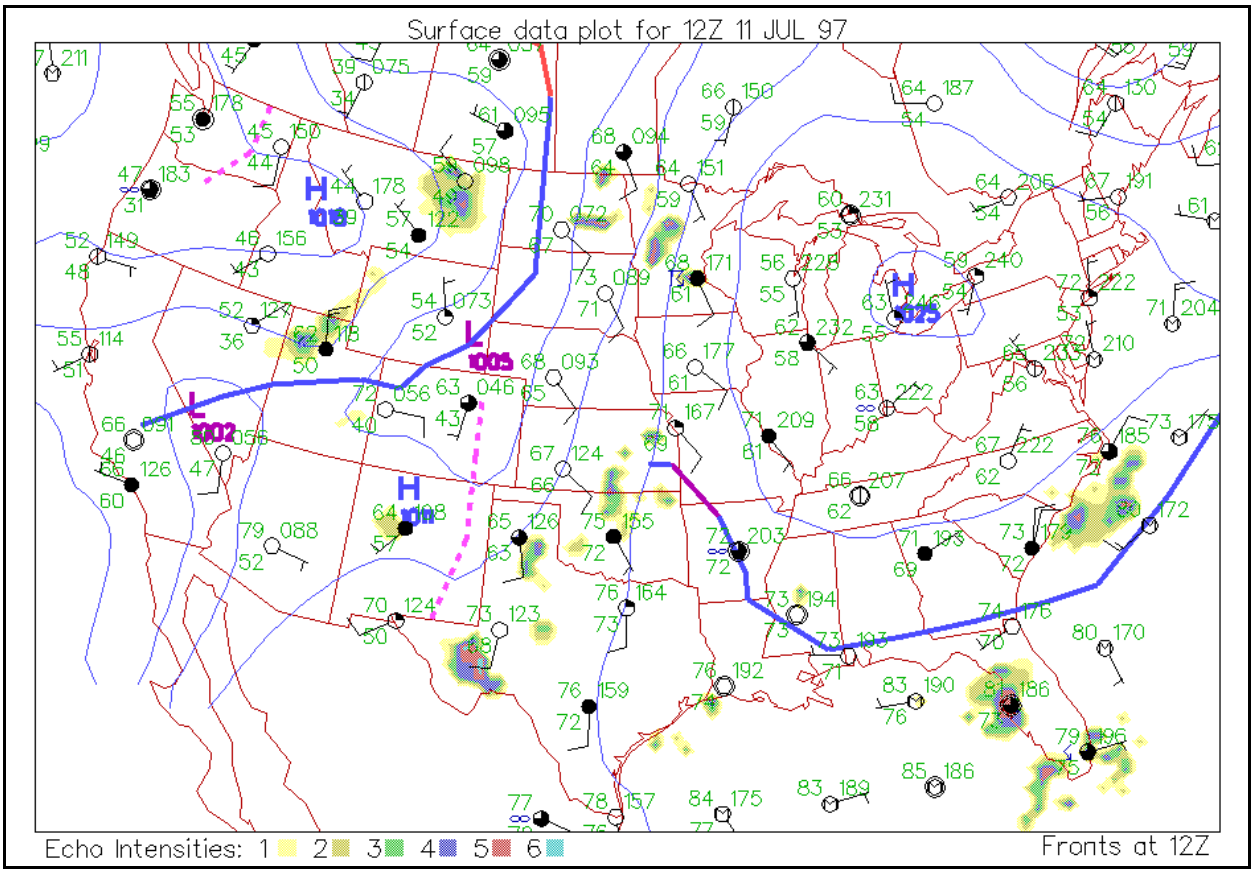

Figure 4 Surface Chart for 12Z July 11, 1997

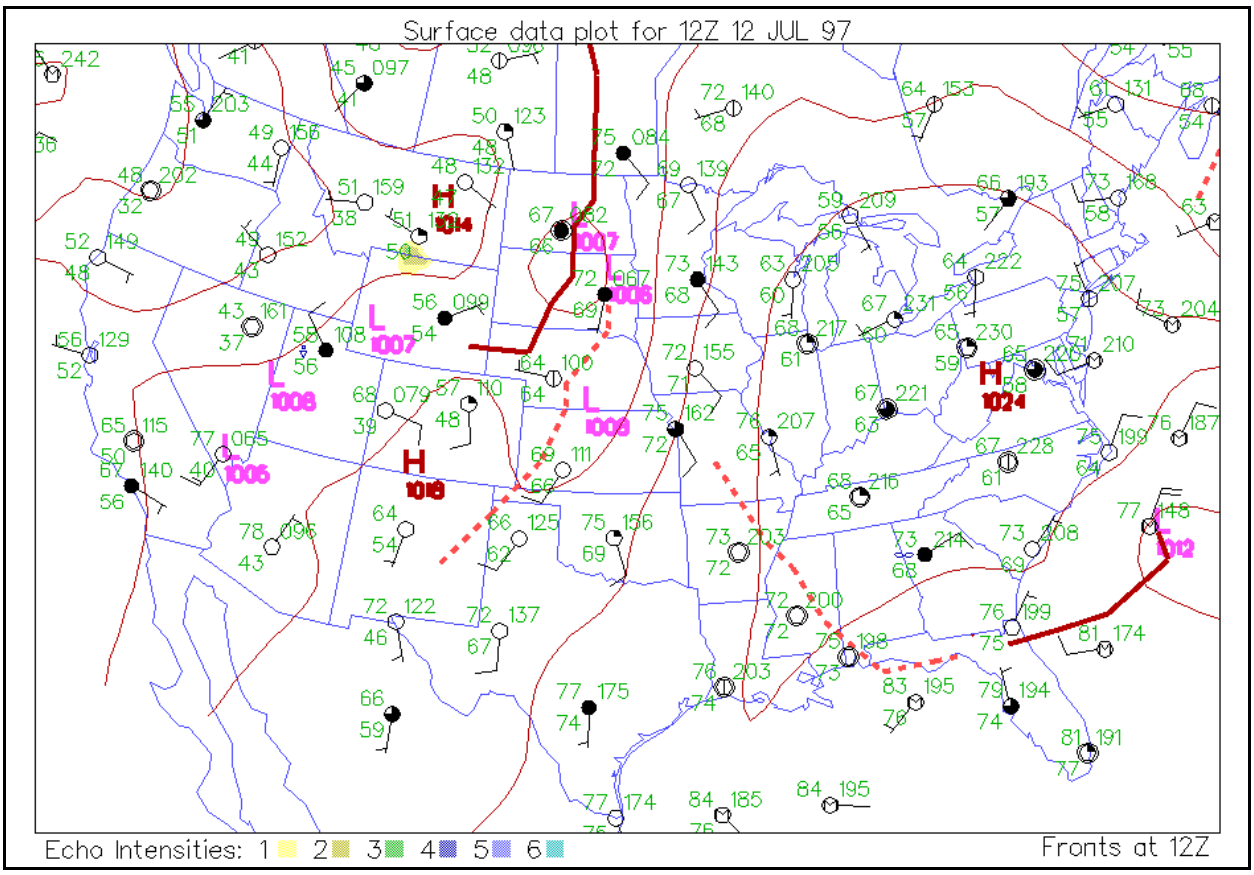

Figure 5 Surface Chart for 12Z July 12, 1997

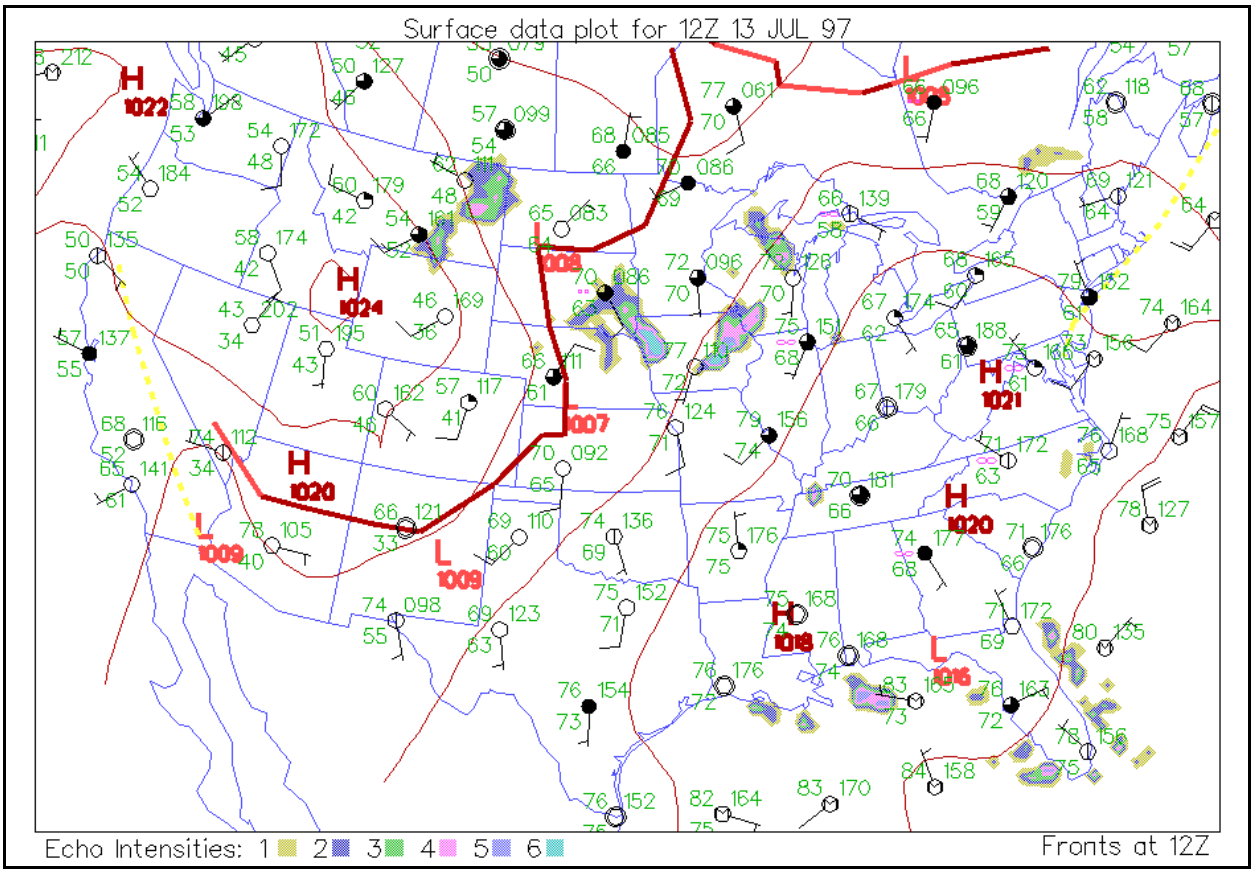

Figure 6 Surface Chart for 12Z July 13, 1997

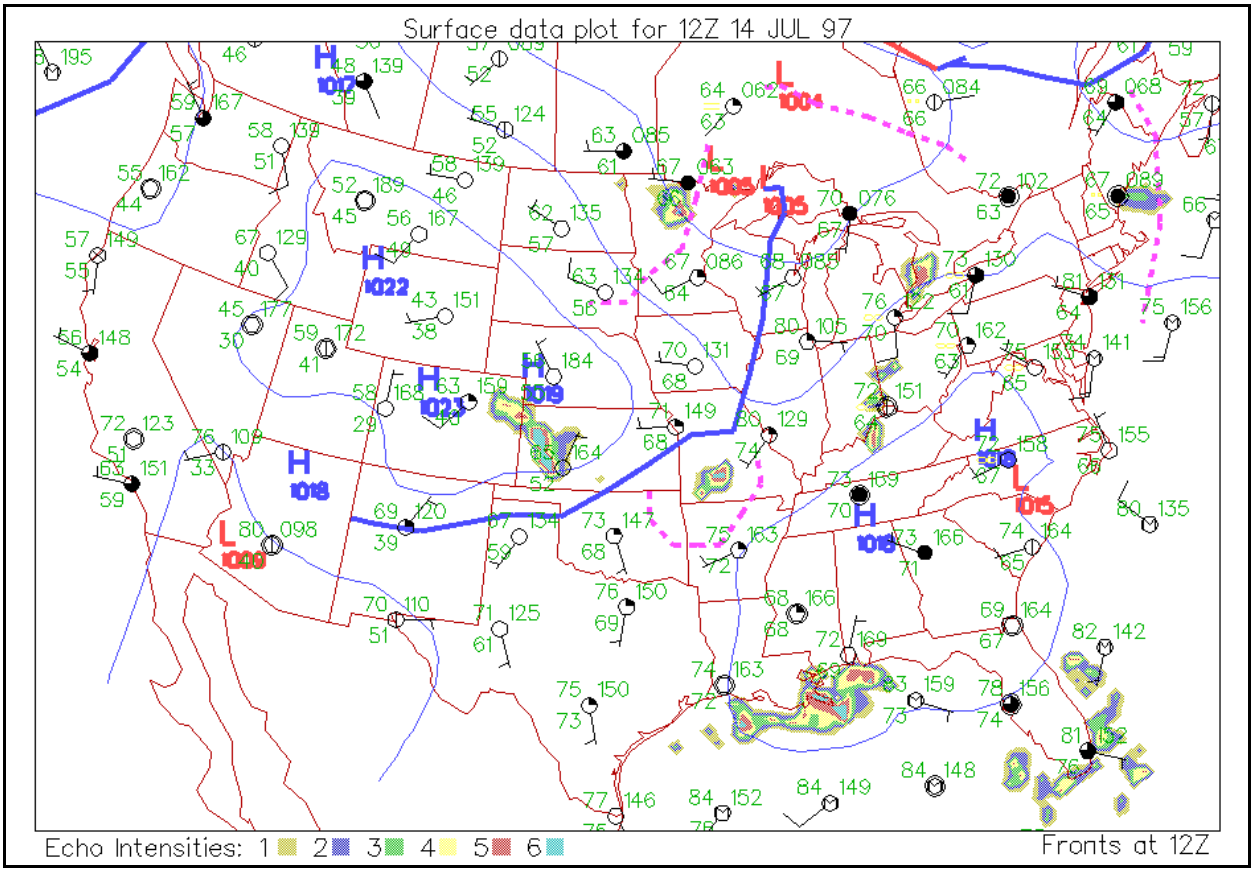

Figure 7 Surface Chart for 12Z July 14, 1997

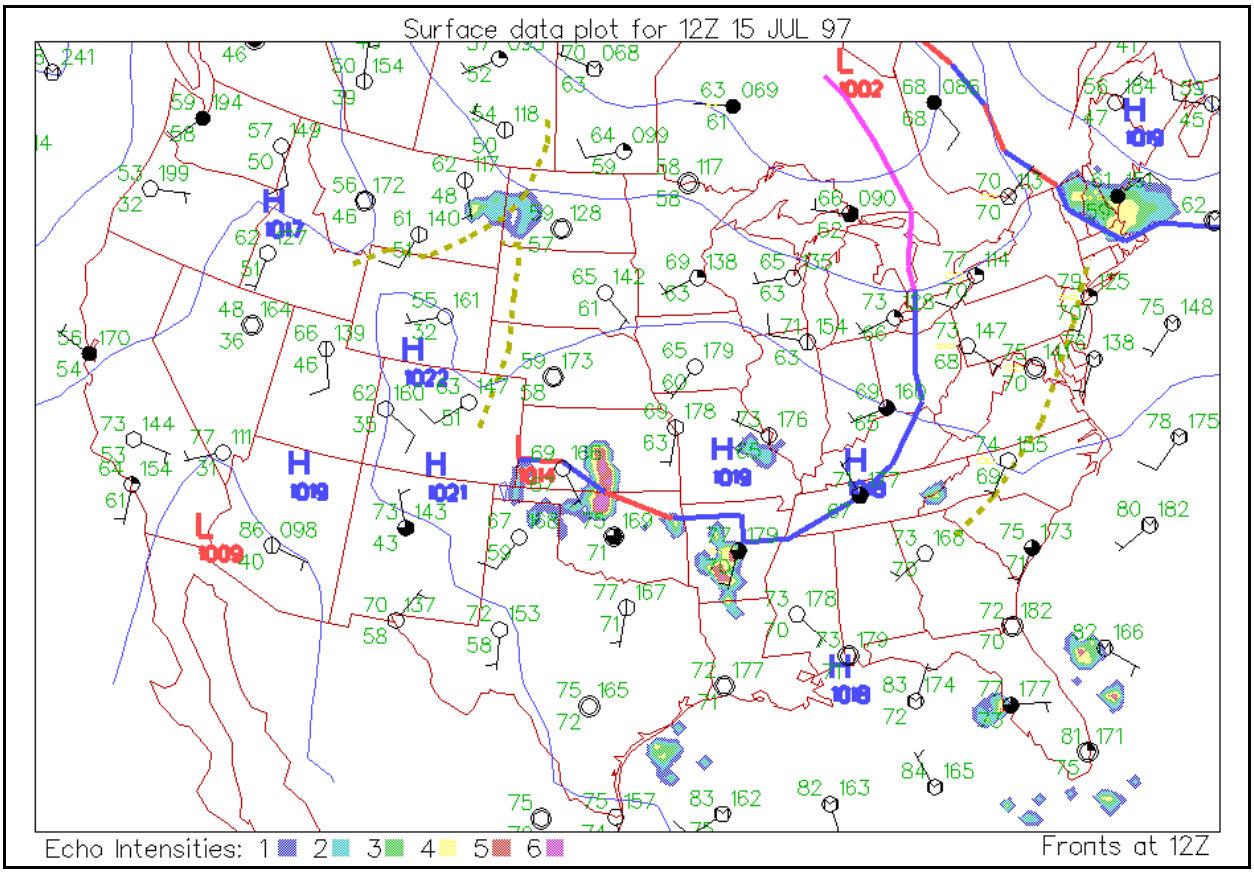

Figure 8 Surface Chart for 12Z July 15, 1997

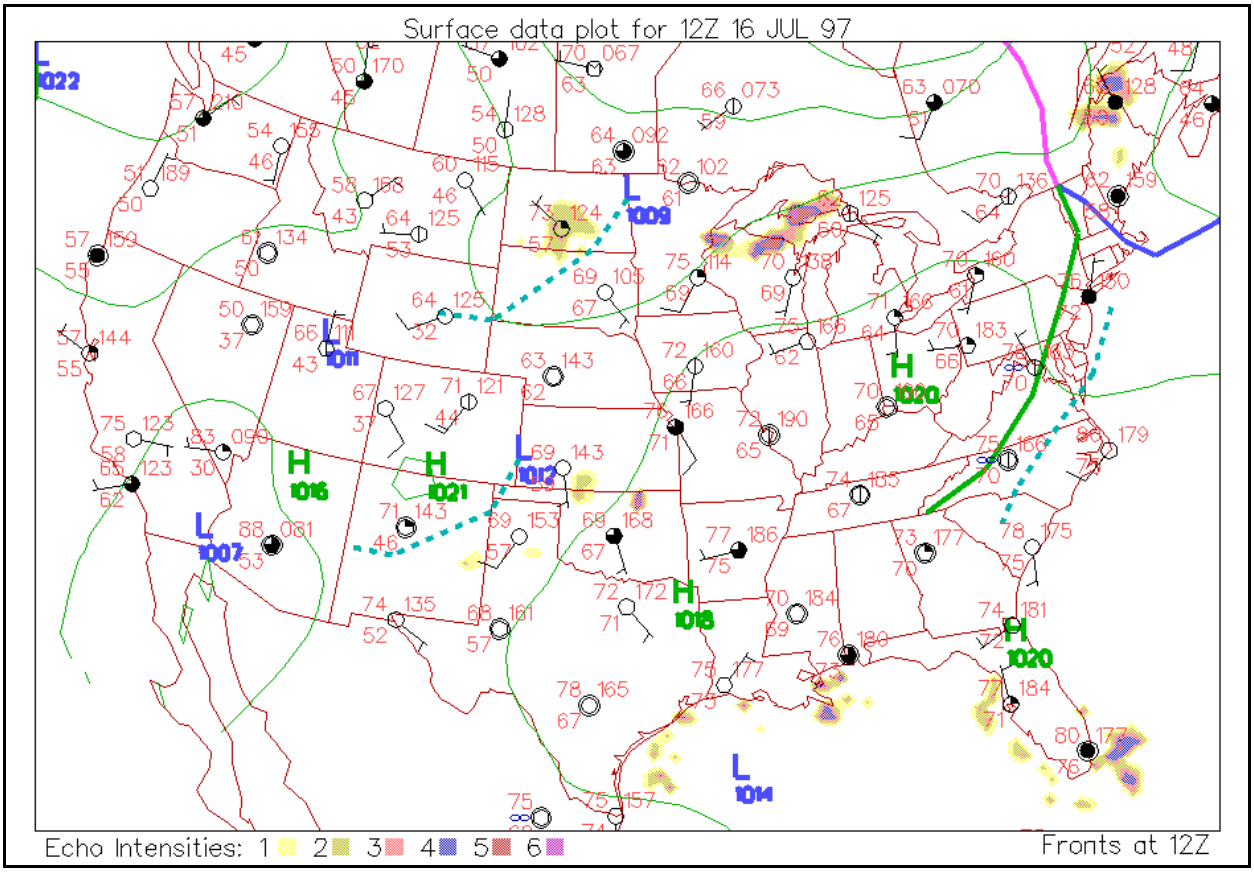

Figure 9 Surface Chart for 12Z July 16, 1997

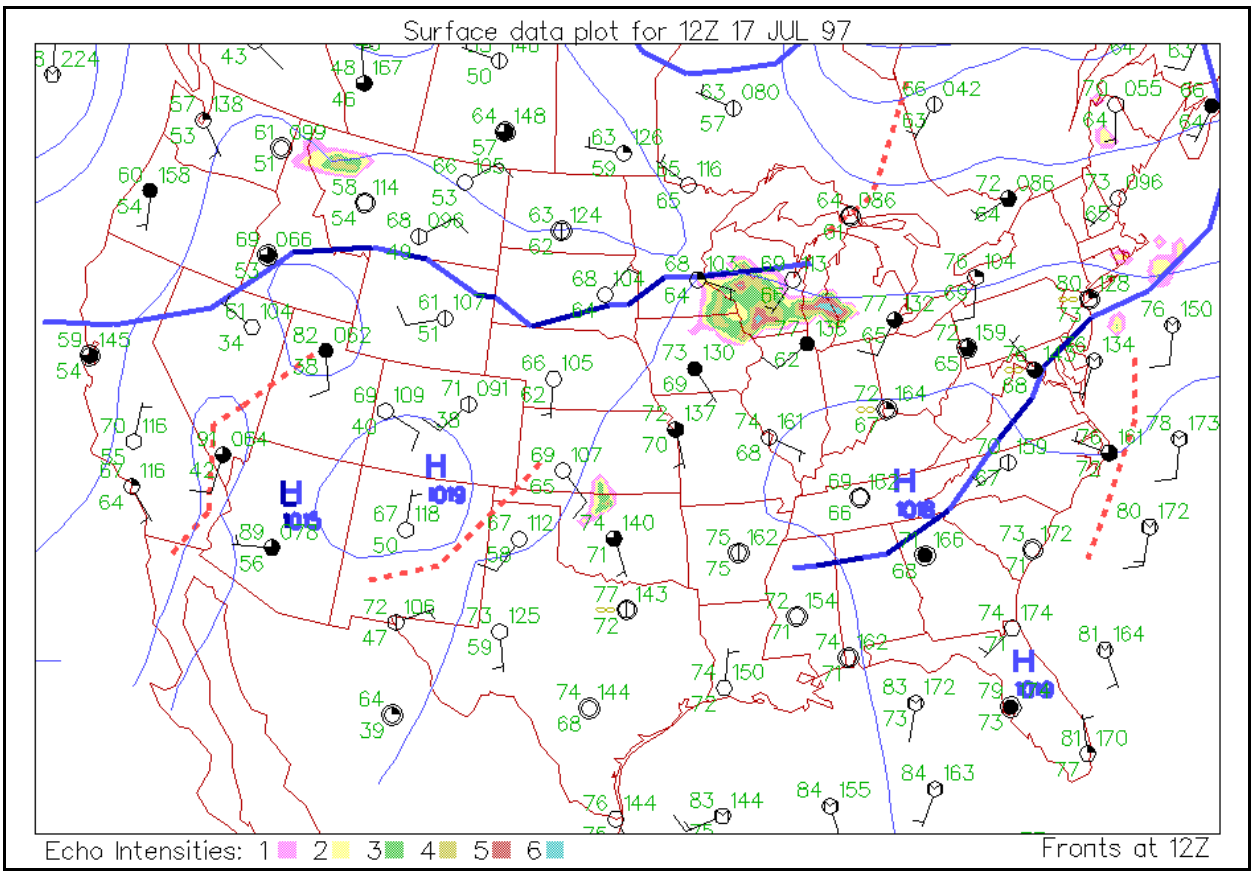

Figure 10 Surface Chart for 12Z July 17, 1997

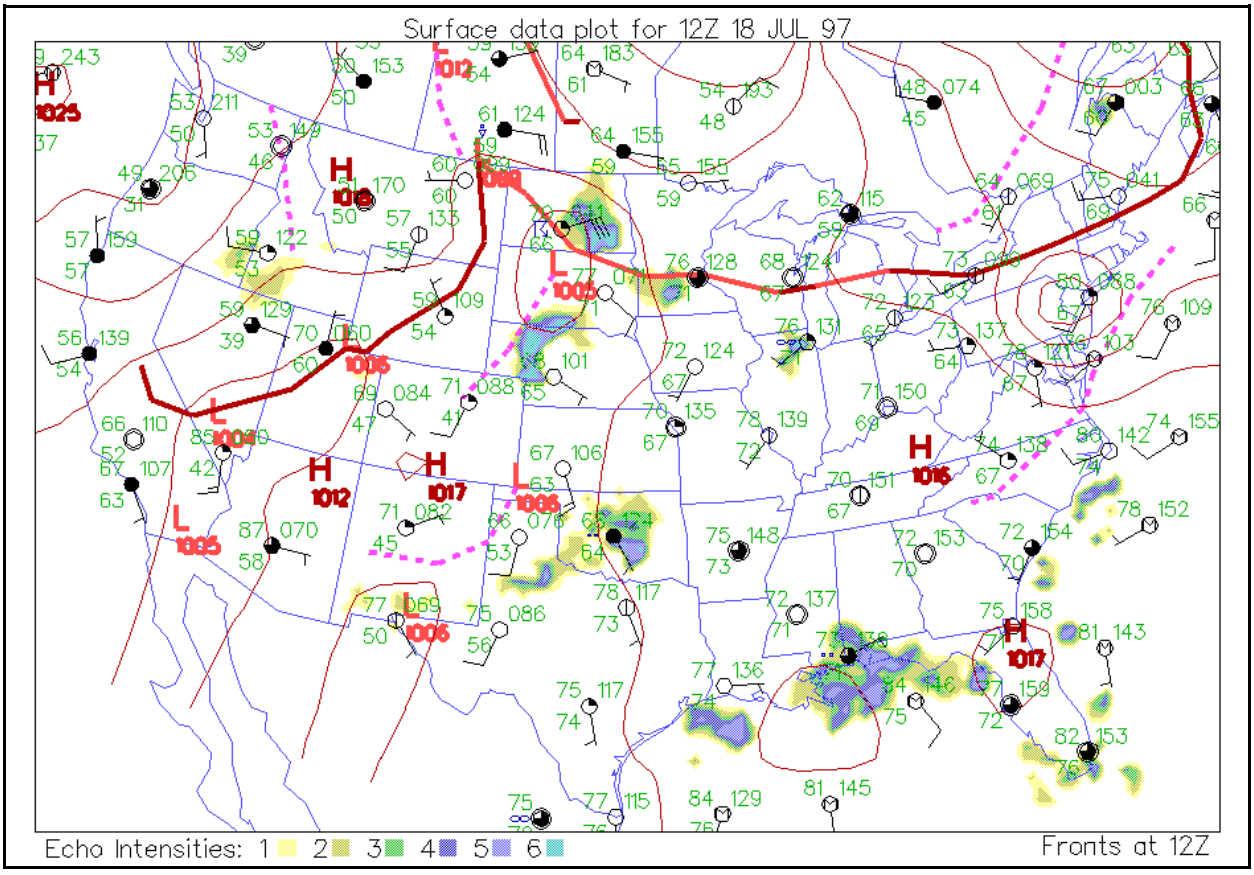

Figure 11 Surface Chart fro 12Z July 18, 1997